International Agricultural Trade
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MEASURING THE EFFECT OF INCREASED HORTICULTURAL IMPORTS: AN APPLICATION TO WINTER VEGETABLES

by

Stephen L. Haley*

Working Paper # 97-1

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*Stephen L. Haley is an economist in the Commercial Agriculture Division, Economic Research Service, U.S. Department of Agriculture.

Correspondence or requests for additional copies of this paper should be addressed to:

Stephen L. Haley
Commercial Agriculture Division
ERS, USDA
1301 New York Ave, N.W.
Washington, D.C. 20005-4788

February 1997

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Stephen L. Haley

Commercial Agriculture Division
Economic Research Service
U.S. Department of Agriculture
Washington, DC

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Abstract

This report describes and applies a methodology to measure the impact of increased horticultural imports on U.S. vegetable producers. The methodology is applied to a hypothetical surge in winter vegetable imports. The paper describes how Florida winter vegetables could be affected by both short-term and long-term changes in import availabilities.

Keywords: Florida, imports, Mexico, trade model, winter vegetables

Acknowledgments

Lon Cesal, Kim Hjort, Barry Krissoff, and Gary Lucier of the Economic Research Service provided many useful comments on an earlier draft of this manuscript. Their kind and diligent assistance is much appreciated.

Measuring the Effect of Increased Horticultural Imports: An Application to Winter Vegetables

Winter vegetables are comprised of fresh tomatoes, bell peppers, squash, cucumber, eggplant, and snap beans. During the winter months, U.S. demand for these vegetables is met with supplies coming from Florida and Mexico. Competition between Florida and Mexico has existed for several decades and has produced its share of trade disputes (Bredahl and others, 1987). Most recently, Florida producers of tomatoes and bell peppers and the Florida Department of Agriculture filed two petitions for relief from Mexican imports. The first was filed with the U.S. International Trade Commission (ITC) and sought relief under Section 201 of U.S. trade law. The petition was denied in July 1996. The second petition alleged dumping or selling below fair market value by Mexican tomato producers. The charges were being investigated by the U.S. Department of Commerce. However, before a preliminary ruling could be made, representatives of a majority of Mexican producers agreed to a price floor of 20.68 cents/pound.

Modeling techniques are relied upon for projections and policy analysis. Properly constructed, they guarantee consistency and logical outcomes (although at times counter-intuitive), given assumptions about market participant behavior and government policy actions embedded within them. Use of modeling tools for vegetables and also fruits has not been as pervasive as for field crops and livestock products. Seasonal production patterns and a wide diversity of products have made model development problematic. Therefore, the first goal of this paper is to present a modeling approach relevant to vegetable and fruit competition issues, recognizing in particular the seasonal nature of the production process.

The second goal is to apply the model to analyzing the effect of increased imports on the Florida producing sector. The analysis is couched in terms of providing answers to two questions. The first question asks what would be the effect on the Florida winter vegetable industry of a sustained rise in imports resulting in a 25 percent increase at the end of a six-year period. Analysis consists in estimating the effect on production, prices, and producer revenue.

The second question asks for the consequences of a supply-shock (e.g. a devastating freeze) when imports can readily fill the gap for the affected products. Consider that with no import response to a supply-shock, prices are driven upward and help provide Florida producers relief for reduced quantities. However, if imports even partially make up for the short-fall, there is less upward price movement, hence less market-generated compensation for Florida producers. The analysis in the paper examines which producers are likely to lose this market-sourced support and by how much they are affected.

Winter Vegetable Overview

Of the winter vegetables, tomatoes have been the most important for Florida vegetable producers. Producer revenue derived from tomato sales has averaged $569.0 million/year over 1988-95. This amount surpasses the yearly summed average revenues from other winter vegetable sales. Next in importance have been bell peppers. Average revenue has been $160.3 million/year. The other vegetables are ranked as follows: cucumbers, $63.3 million/year; snap beans, $56.1 million/year; squash, $41.9 million/year; and eggplant, $13.6 million/year.

Winter vegetables are grown in a variety of areas within Florida. Table 1 shows a representative year's distribution of vegetables across Florida producing regions. Most acreage tends to be concentrated along the central west coast, and the southwestern and southeastern regions. Tomatoes comprise the most acreage, in aggregate and in most areas where it is produced. An exception is the southeast (Dade county) where most of the state's snap bean acreage tends to be located - over 80 percent.

Each of the vegetable producing sectors faces important competition from Mexican imports. However, the degree of competition differs among them. Table 2 shows imports as a proportion of total winter shipments for the 1984/85-93/94 period and for each of 1993/94 and 1994/95. Cucumbers and squash have the highest proportions of

Table 1 - Representative Distribution of Florida Winter Vegetable Acreage

Region	Tomato	Bell Pepper	Squash	Cucumber	Eggplant	Snap Bean
West	2950	0	50	0	0	300
North	0	500	450	500	300	1900
North Central	1150	1000	500	400	55	0
West Coast	12800	3400	2400	2600	125	1500
East Coast	0	0	300	0	0	0
Southwest	21500	9500	3700	2500	320	0
Southeast	11200	7200	5900	5600	1600	21800
Total	49600	21600	13300	11600	2400	25500

Table 2 - Imports as a Proportion of Total Winter Shipments

Product	Average: 1984/85-93/94	1993/94	1994/95
Tomato	28.7%	31.2%	38.4%
Bell Pepper	35.0%	30.9%	42.9%
Squash	50.3%	51.8%	63.0%
Cucumber	52.8%	60.6%	59.1%
Eggplant	40.6%	38.8%	49.7%
Snap Bean	16.3%	14.1%	17.9%

imports, typically over 50 percent. Snap beans have the lowest proportions. Although tomatoes receive most of the attention, their import proportions are typically below those for squash, cucumbers, eggplant, and sometimes bell peppers. Even in 1994/95 when tomato imports surged, the import ranking was the second lowest, only behind snap beans.

Table 3 - Winter Vegetable Shipment Growth Rates, 1979-95

Product	Florida Shipment Growth Rate	Mexican Shipment Growth Rate
Tomato	3.24%	2.05%*
Bell Pepper	6.64%	5.98%
Squash	4.90%	6.00%
Cucumber	3.64%	2.68%
Eggplant	0.49%*	1.79%*
Snap Bean	0.87%*	1.77%*

* = not significantly different from zero at $\alpha = .05$.

Table 3 shows shipment growth rates from 1979 through 1995. Growth rates for bell peppers and squash have been the highest for both Florida and Mexico. Shipment levels for eggplant, snap beans, and Mexican tomatoes have been sufficiently variable so that the rates cannot be shown to be significantly different from zero. Also, in none of the cases are there statistical differences between Florida and Mexican growth rates. Growth, at least measured over time, has been shared fairly equally by both supply regions.

Figures 1a-1f show monthly shipments for Florida and Mexican winter vegetables averaged over 1979-94 and 1991-94. A comparison of the averages gives a picture of the growth occurring since the early 1980's.

The figures show that Mexican import presence is strongest during January through March. It is then that Florida production tends to dip.[1] Mexican imports clearly dominate during the same period for cucumbers, squash, and eggplant. Florida competition presence is stronger then for both tomatoes and bell peppers. The trend in pepper shipments, in particular, has risen the most. Florida is clearly dominant in shipments of snap beans throughout the season.

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[1]Certain Florida regions, however, do compete more directly with Mexican imports. Tomatoes are a good example. The Florida Tomato Committee, an official producer group, divides production areas into 4 districts. For 1994/95, monthly shipments out of districts 2, 3, and 4 show nonexistent or negative correlation with Mexican shipments. District 1, which is essentially Dade county in the southeast, shows a correlation coefficient of 0.86, indicating very similar shipment pattern as the imports.

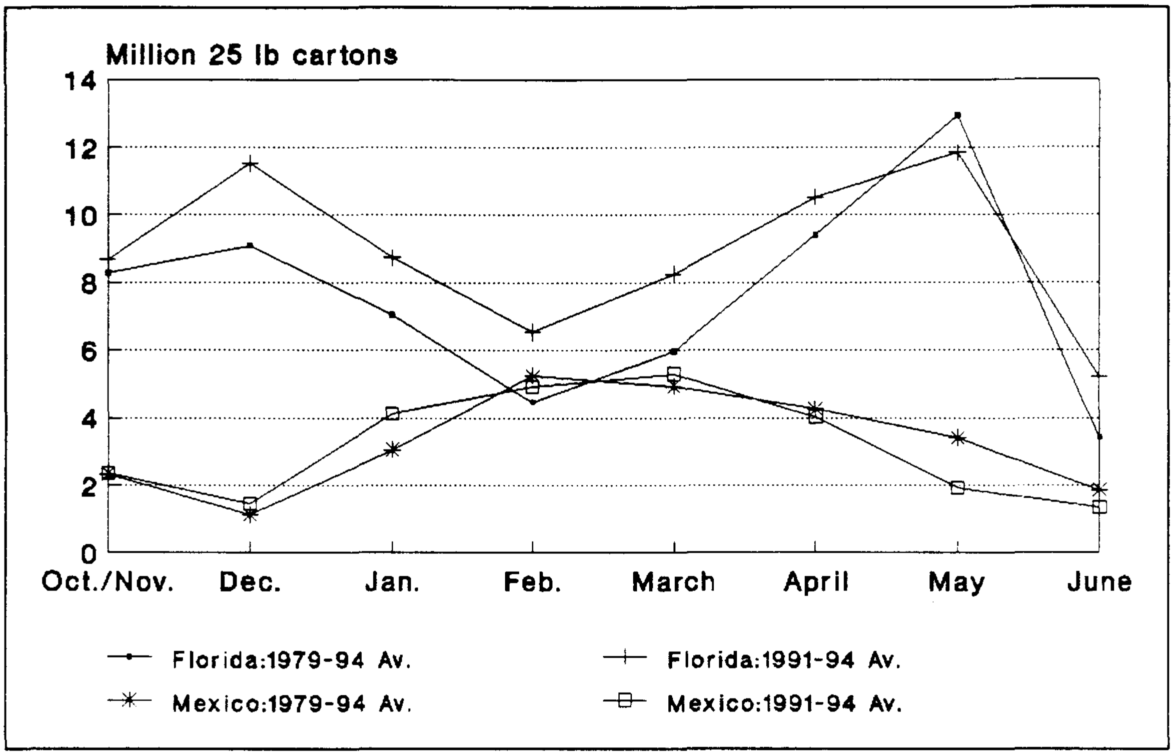

Figure 1a - Average Monthly Shipments of Tomatoes

Analytical Framework

Analysis of winter vegetable trade needs to recognize several key elements. First, the trade is seasonal: it extends from October through June, with most of the competition occurring in the January to April period. Second, the primary sourcing areas are various producing regions of Florida and Mexico. Third, monthly shipment levels tend to be highly variable. They are significantly affected by weather disturbances, and the perishability of the products does not permit the same type of storage opportunities available to field crop producers and marketers.

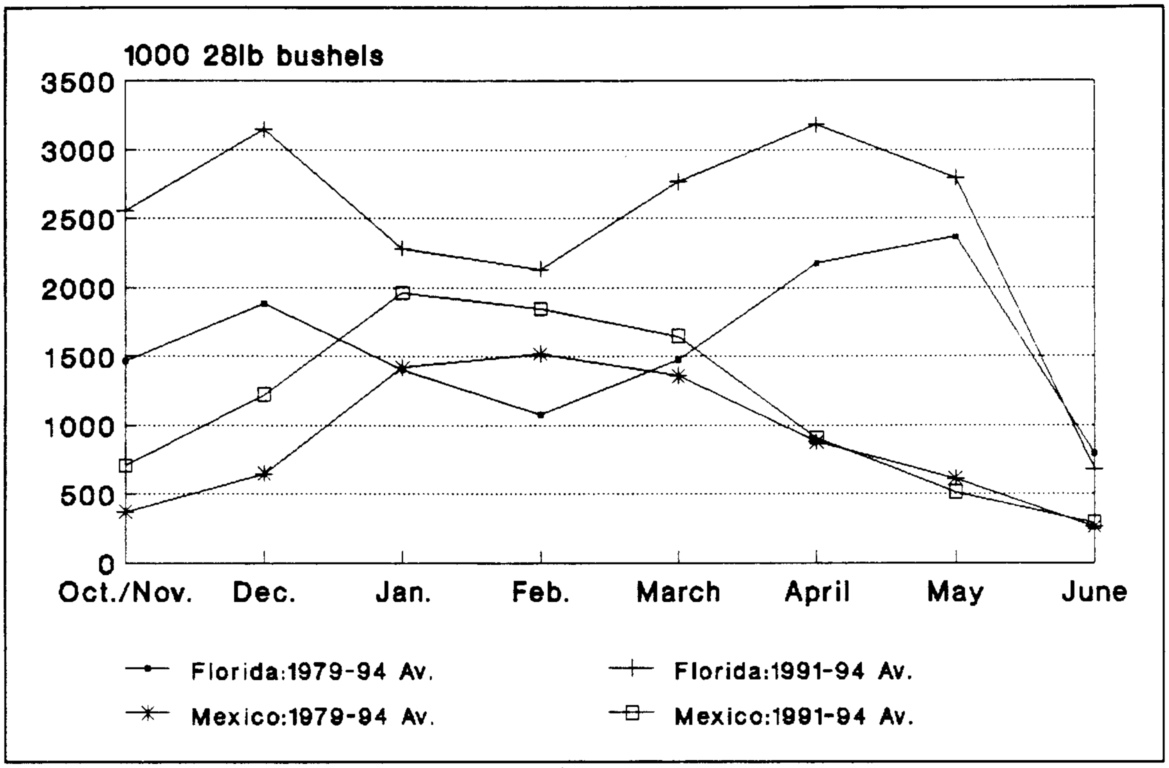

Figure 1b - Average Monthly Shipments of Bell Peppers

The analytical framework attempts to deal with these issues. In short, the system is structured recursively. Box 1 outlines an eight-step procedure that is captured within the framework. The framework distinguishes what is expected at the beginning of the production and shipment schedule (steps 1-3), and what is predicted to occur as monthly production levels are affected by the weather and other unanticipated disturbances (steps 4-8).

This latter part of the system captures stochastic components of variable monthly supply. The system produces a set of results from which an averaged level is calculated, along with a variance. Results (e.g. Florida shipment levels, prices, producer revenue), therefore, are more in the nature of intervals than point

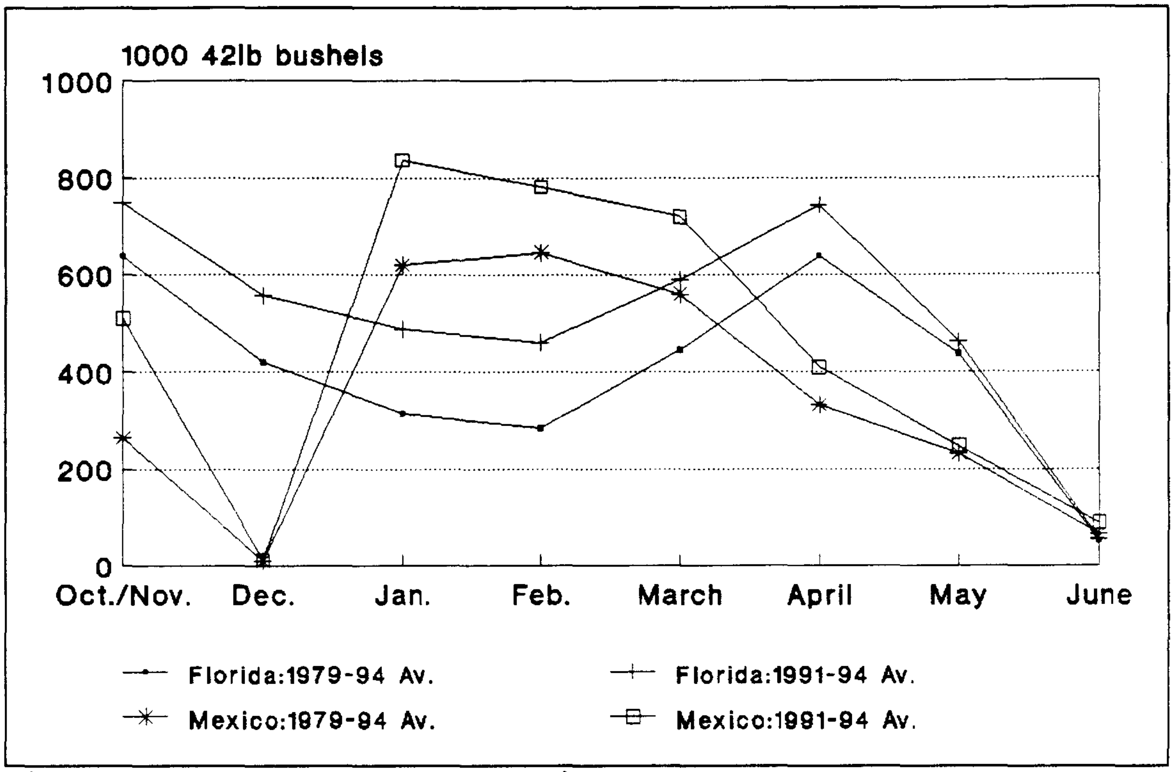

Figure 1c - Average Monthly Shipments of Squash

estimates. An advantage of interval prediction is that results from a scenario can be statistically compared to corresponding results from a baseline. Assuming more or less equal variances among variables being compared across the experiments, a t-test can be performed to determine the significance level of differences in results between the scenario and baseline.

System Description: Steps 1-3

The modeling system itself is flexible. The essential ideas are described in Box 1. The substance is made up of specific parameter values that capture assumptions about and measures of the

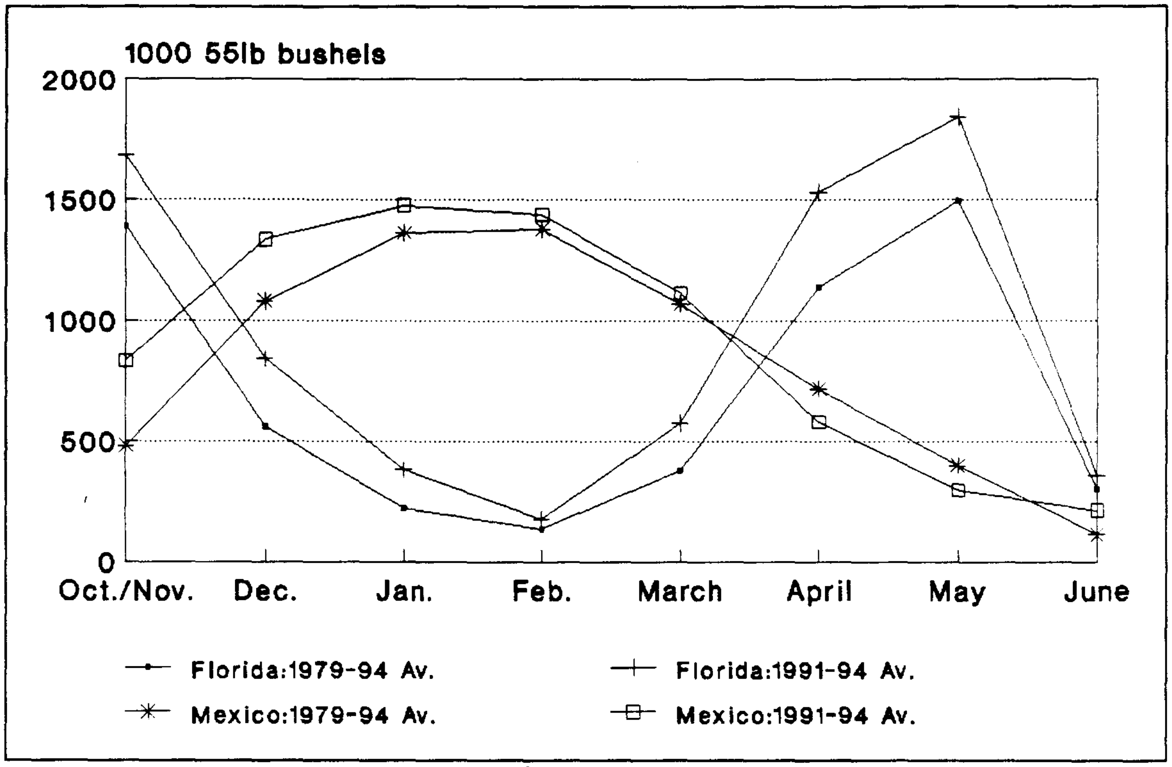

Table 1d- Average Monthly Shipments of Cucumbers

responsiveness of parts of the system to changes in other parts.

The choice of a baseyear (which sets the starting period for the analysis) and the length of the analysis period is arbitrary. For the present exercise, the 1993/94 season is used as the baseyear. Complete data from earlier periods and 1994/95 are available (Florida Agricultural Statistics Service, 1996; FATUS, 1996). The 1994/95 year, however, represents the period when Mexican vegetable imports surged well beyond historical patterns and may, therefore, not be a good representative year about which to base analysis.

Results are provided for a 6-year projection period. This length of time is somewhat arbitrary. In the first experiment, Mexican

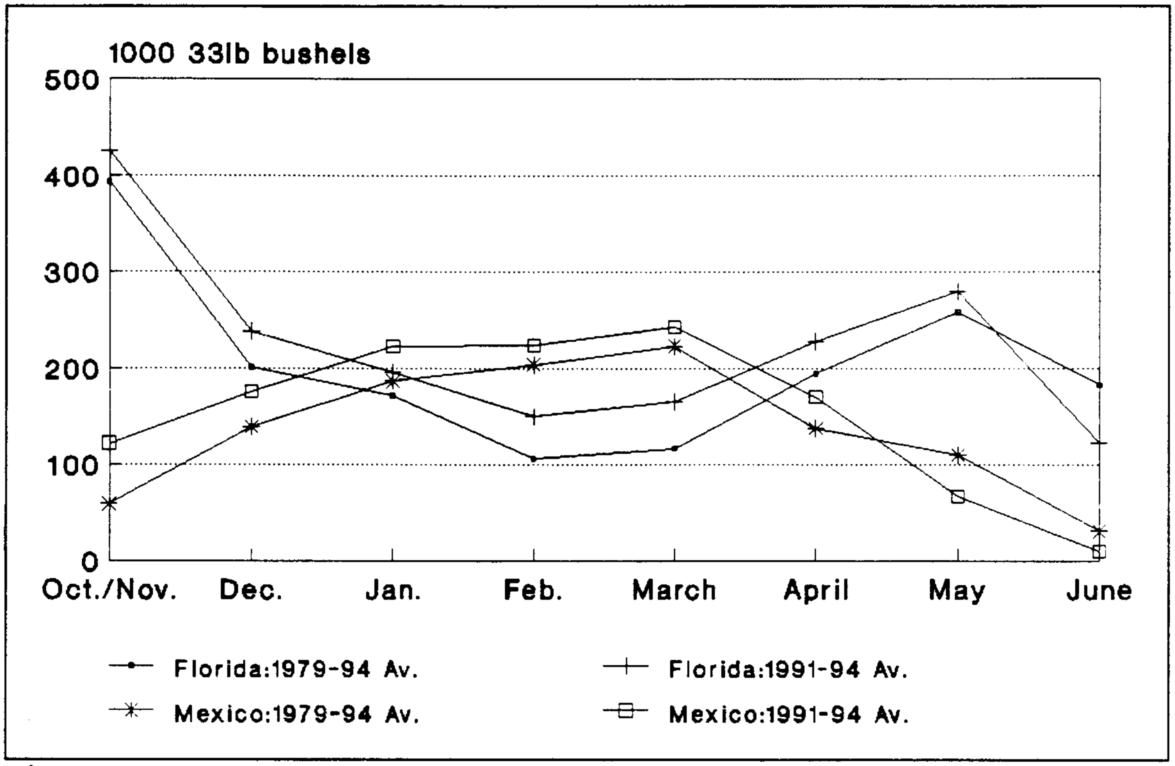

Figure 1e - Average Monthly Shipments of Eggplant

imports are specified to grow by 25 percent. It seems reasonable to allow this growth to occur over some period of time - in this case, 6 years. For the second experiment, where there is a supply-shock affecting Florida vegetable production, just a single year is necessary for analysis as inter-year adjustments would be expected to be of secondary importance.

The system does not represent a complete accounting of all winter vegetable supply sourcing - only Florida and Mexico are considered. Other sourcing areas are presumed irrelevant to the present analysis.

Florida production is broken down into regions. Production is a

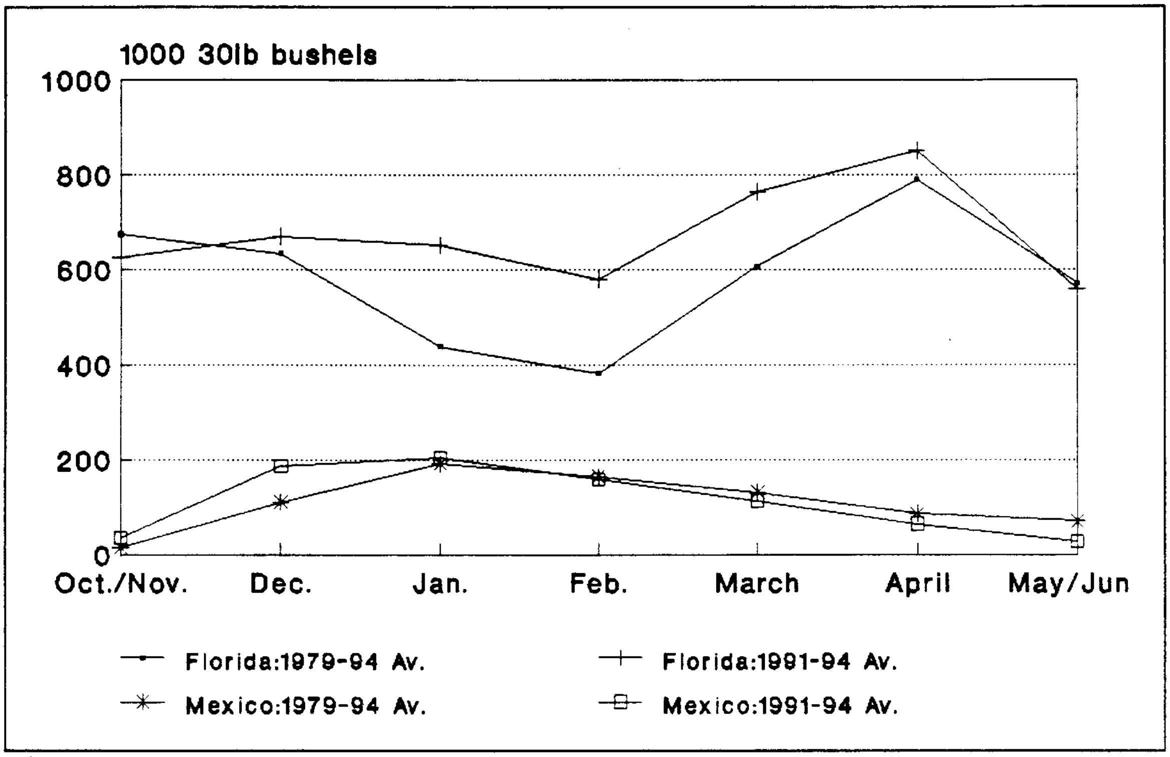

Figure 1f - Average Monthly Shipments of Snap Beans

product of acreage and yield. Acreage and yield response equations were estimated as a function of lagged producer prices. Although results are not reported here (but are available from the author), they indicate relatively inelastic responses to producer price changes. More important are yield growth changes. These yield trends were estimated from data 1985 through 1994 (Table 4) and included in expected production computations.

While much is known or can be estimated for Florida production, the same is not true for Mexico. Given the concern of this paper (i.e., the effect of increased imports on Florida producers), a thorough understanding of Mexican production is not necessary (i.e., it would be desirable but the costs are high).

1. Expected production is estimated, based on lagged unit returns to producing and yield trends.

2. Expected level of imports is estimated, based on a predicted level of consumption less expected production from step no. 1.

3. Expected domestic shipments and imports are distributed over the October - June period, based on average monthly distribution percentages from 1985-94.

4. For each month, a set comprised of a fixed-number of deviations from the expected shipment levels is generated, assuming that deviations from the expected levels are normally distributed, with a mean of zero and finite variance that is estimated from observations for each month over 1985-94.

5. The numbers from the set of deviations from step no.4 are summed with expected shipment levels (step no.3) to produce a set of estimates of monthly shipments across the October-June season.

6. Monthly demand equations with price as the dependent variable map estimated shipments and imports into a set of monthly shipment prices and import unit-values.

7. Prices from step no.6 and quantities from step no. 5 are used to calculate a set of producer revenues corresponding to individual elements of sets referred to in steps 5 and 6. Average producer revenue is calculated, along with the variance.

8. A set of season-average, yearly prices are calculated. The average price is calculated, along with the variance.

Box 1 - Analytical Framework

The procedure embedded in the system is to calculate expected yearly Mexican imports residually. The expected joint consumption of Florida and Mexican winter vegetables is assumed to grow at a 1.5 percent rate through the simulation period. The expected level

Table 4 - Estimated Percentage Yield Growth in Florida

Region	Tomato	Bell Pepper	Squash	Cucum-ber	Egg Plant	Snap Bean
West	4.46	na	5.64	na	na	4.10
North	na	5.99	4.54	0	3.58	11.40
North Central	2.16	12.90	6.10	0	2.29	na
West Coast	0	3.69	7.00	0	2.86	8.84
East Coast	na	na	5.50	na	na	na
Southwest	0	8.72	8.17	5.37	2.01	na
Southeast	3.39	6.03	0	5.19	0	0

na = not applicable

of production aggregated across Florida regions is subtracted from expected consumption to produce an initial estimate of Mexican imports for the system's baseline. In subsequent experiments, where Mexican imports are specified to increase, predicted consumption levels will be higher than expected levels. As is explained below, the increase is accommodated by lower prices.

The calculation of expected intra-year vegetable shipments are based on average monthly distribution patterns observed over 1985-94, for total shipments out of both Florida and Mexico.

System Description: Steps 4-8

At this point the system has allowed for expected shipments out of Florida and Mexico, distributed over the October to June season, based on observed patterns occurring in some prior period. Actual distributions and shipment levels, however, do not conform to the averages. The goal is to have a distribution of results centered about their respective means and possessing statistical variances close to those observed over some specified period.

The procedure is now to allow for variable shipment levels, at least for Florida; then map the results into prices, from where producer revenues and unit returns can be calculated. Deviations from expected monthly shipment levels are assumed to be potentially correlated with disturbances occurring up to 4 months prior to the current period (but going back only to the start of the season, i.e. October) and with contemporaneous disturbances affecting other winter vegetables.

For each month a set comprising 50 elements and representing disturbances from the means are generated. The corresponding elements of each set comprises a system iteration. Starting with the first month (October), the disturbances are added to the corresponding expected shipment levels to give predicted shipment levels.

Table 5a - Florida Demand Flexibilities - Tomatoes and Bell Pepper

Tomato

Month	Florida Quantity	Import Quantity	Total Quantity	Previous Month Price
October	-1.202	0	0	0
November	-1.202	0	0	0
December	0	0	-1.040	.702
January	0	0	-1.685	0
February	0	0	-0.759	.739
March	0	0	-0.416	.483
April	-1.230	0	0	.663
May	-0.453	0	0	.681
June	-0.057	0	0	.412

Bell Pepper

Month	Florida Quantity	Import Quantity	Total Quantity	Previous Month Price
October	0	0	-0.345	0
November	0	0	-0.262	0
December	0	0	-0.324	0
January	0	0	-0.532	0
February	0	0	-0.310	1.031
March	0	0	-0.595	.673
April	0	0	-1.069	0
May	0	0	-1.288	0
June	0	0	0	.568

Table 5b - Florida Demand Price Flexibilities - Squash and Cucumber

Squash

Month	Florida Quantity	Import Quantity	Total Quantity	Previous Month Price
October	0	0	-0.816	0
November	0	0	-0.854	.359
December	0	0	-0.499	0
January	0	0	-0.372	.503
February	0	0	-0.359	.494
March	0	0	-0.456	0
April	0	0	-0.201	.354
May	0	0	-0.374	0
June	0	0	-0.466	.701

Cucumber

Month	Florida Quantity	Import Quantity	Total Quantity	Previous Month Price
October	0	0	-0.260	0
November	0	0	-0.260	.805
December	0	0	-0.243	.577
January	0	0	-1.718	0
February	0	0	-0.267	.856
March	0	0	-0.240	.384
April	0	0	-0.774	.374
May	0	0	-0.693	.146
June	0	0	0	.771

These shipment levels are linked to prices through monthly demand equations estimated for this purpose in price-dependent form. The

Table 5c - Florida Demand Price Flexibilities - Eggplant and Snap Beans

Eggplant

Month	Florida Quantity	Import Quantity	Total Quantity	Previous Month Price
October	0	0	-0.600	0
November	0	0	-1.274	.608
December	0	0	-0.748	0
January	0	0	-0.663	.869
February	0	0	-0.394	0
March	-0.348	-0.138	0	.394
April	-0.422	-0.116	0	0
May	-0.429	0	0	0
June	-0.864	-0.148	0	.714

Snap Beans

Month	Florida Quantity	Import Quantity	Total Quantity	Previous Month Price
October	0	-0.086	0	0
November	0	0	-1.146	-0.402
December	0	0	-0.700	0
January	0	0	-0.210	.408
February	-0.063	-0.114	0	.677
March	0	0	-0.563	.446
April	0	0	-1.020	0
May	-0.256	0	0	0
June	0	0	0	.570

prices are a function of shipment quantities (Florida and Mexican or the total) and the previous month's price. There are no cross-price effects. Parameter values are shown in tables 5a through 5c. For the most part, price demand elasticities are fairly elastic. Exceptions are tomatoes in December and January; bell peppers in April and May; cucumbers in January;eggplant in November; and snap beans in November and April.

Although not explicitly used in this analysis, there are also equations that link unit import values to shipment levels, the Florida price, and the previous month's unit import value. At the next step, yearly producer revenues are calculated, and then weighted yearly prices. After a complete iteration has been run over the 6-year term, a new iteration is started and the process continues. At the end of the iterations, results are presented as averages, with variances.

Baseline Results

Table 6a shows baseline results for tomatoes, bell peppers, and squash. Table 6b does the same for cucumber, eggplant, and snap beans. The tables show levels of production (or total season shipments), imports, year producer unit values (or yearly prices), and producer revenues.

Unit values uniformly are shown to decrease for all the vegetables over the 6-year period. Snap beans decrease the least, 3 percent;

Table 6a - Baseline Projections: Tomatoes, Bell Peppers, Squash*

Product	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Tomato						
Production	67304.818	64686.521	65985.641	67187.367	67140.470	67854.394
Imports	31570.729	33950.304	34964.279	35813.252	37054.402	38085.412
Producer Unit Value	6.856	7.012	6.749	6.536	6.462	6.346
Revenue (Million Dls)	460.829	452.580	444.429	438.601	433.096	430.040
Bell Pepper						
Production	25266.488	27375.427	28729.842	30935.127	32707.041	35495.305
Imports	9575.243	8405.123	7217.755	5707.133	4012.434	2136.384
Producer Unit Value	9.131	8.943	8.913	8.794	8.789	8.677
Revenue (Million Dls)	230.454	244.561	255.771	271.801	287.218	307.724
Squash						
Production	4485.857	4529.661	4710.819	4918.913	5144.162	5399.732
Imports	5075.192	5260.686	5143.187	5078.337	4991.845	4885.234
Producer Unit Value	9.428	9.312	9.223	9.109	9.015	8.892
Revenue (Million Dls)	42.279	42.164	43.431	44.793	46.363	48.002

* Tomatoes: 1000 25lb. cartons
Bell Peppers: 1000 28lb. bushels
Squash: 1000 42lb. bushels

Table 6b - Baseline Projections: Cucumber, Eggplant, Snap Bean[*]

Product	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Cucumber						
Production	6408.741	7923.569	8425.789	8547.429	8791.026	9091.956
Imports	8360.875	7021.229	6717.797	6813.906	6802.288	6752.941
Producer Unit Value	11.573	11.224	11.085	10.966	10.873	10.739
Revenue (Million Dls)	74.136	88.912	93.381	93.717	95.555	97.623
Egg Plant						
Production	2106.783	2171.232	2162.143	2168.543	2173.960	2184.083
Imports	1202.303	1202.770	1246.304	1294.396	1348.082	1399.083
Producer Unit Value	8.723	8.582	8.524	8.459	8.391	8.292
Revenue (Million Dls)	18.370	18.629	18.422	18.337	18.239	18.107
Snap Bean						
Production	4481.696	3943.610	4077.660	4215.135	4175.370	4206.710
Imports	778.095	1297.790	1307.618	1308.314	1401.752	1450.878
Producer Unit Value	12.499	12.696	12.444	12.285	12.195	12.080
Revenue (Million Dls)	55.971	50.006	50.681	51.677	50.875	50.757

* Cucumber: 1000 55lb. 1 1/9 bushels
Egg Plant: 1000 33lb. bushels
Snap Bean: 1000 30lb. bushels

while cucumbers and tomatoes decrease the most, about 7 percent. Production trends are more variable. Some of the vegetables show high growth over the period: cucumbers, 42 percent; bell peppers, 40 percent; and squash, 20 percent. Low to nonexistent growth is indicated for eggplant (4 percent) and tomatoes (0.8 percent). Snap bean production is expected to decrease by 6 percent.

Figure 2 shows the yearly projected growth rates for producer revenue. Bell pepper and cucumber producers show the strongest gains, above 4 percent. Squash producers show some growth, while

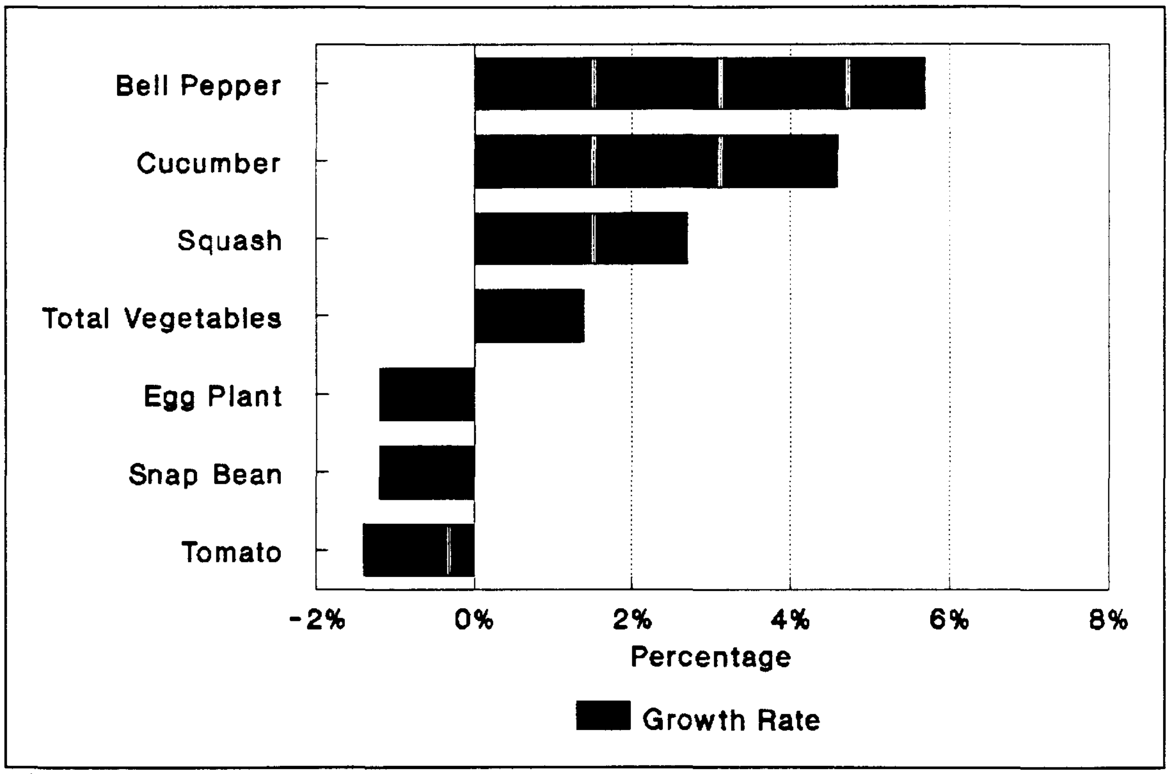

Figure 2 - Baseline Projection: Yearly Producer Revenue Growth

producers of eggplant, snap beans, and tomatoes show negative growth of more than 1 percent. The entire sector shows a modest producer revenue growth rate of 1.4 percent.

Effects of Import Growth on Florida Producers

One of the purposes of this paper is to analyze the vulnerability of the Florida winter vegetable industry to Mexican import competition. The procedure is to ask two specific questions in which the vulnerability is made manifest. The first question, around which this section is organized, is: what is the effect of a sustained rise in Mexican vegetable imports? The analytical framework has been constructed to answer this question by comparing changes in monthly and yearly prices, production levels, and producer revenues to the baseline solution.

The scenario is carried out by exogenously increasing imports in each projection year by one-sixth of 25 percent so that the 25 percent increase is in full effect at the end of the projection period.

Table 7 shows the effect of increased imports on the percentage of imports in total winter vegetable consumption. The baseline analysis had suggested increased import dependence for snap beans, tomatoes, and eggplant. The increased growth of imports strengthens this trend. The baseline analysis had suggested decreasing import dependence for bell peppers, squash, and cucumber. Increased

Table 7 - Imports as Proportion of Winter Vegetable Consumption

Product	1994 - Actual	2000 - Baseline	2000 - Scenario
Tomato	31.2%	36.0%	42.0%
Bell Pepper	30.9%	5.7%	7.5%
Squash	51.8%	47.5%	53.5%
Cucumber	60.6%	42.6%	51.6%
Egg Plant	38.8%	39.0%	46.3%
Snap Beans	14.1%	25.6%	33.1%

imports invalidate this conclusion for squash and cucumbers, but does not reverse it by indicating significantly more import dependence. Bell peppers are the only product in which the trend toward decreasing import dependence remains intact.

Table 8 shows the effects of the sustained import rise on production, yearly price, and producer revenue. As would be expected, producer prices decrease. At the end of the simulation period, the following percentage reductions in producer prices are found (in order of the greatest reduction to the least): tomatoes, 6.9 percent; cucumber, 6.8 percent; squash, 6.1 percent; eggplant, 3.8 percent; snap bean, 3.5 percent; and bell pepper, 1.3 percent. Indicative of inelastic supply, Florida vegetable production is not much affected. The largest decrease is for cucumbers, 5.9 percent. Squash, bell pepper, and tomato production are reduced by less than 1 percent from baseline levels.

Table 8 - Production, Price, and Revenue Ratios

Production

Products	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Tomato	1.000	0.998	0.995	0.992	0.990	0.988
Bell Pepper	1.000	0.999	0.998	0.996	0.996	0.996
Squash	1.000	1.000	0.998	0.995	0.994	0.992
Cucumber	1.000	0.989	0.975	0.963	0.952	0.941
Eggplant	1.000	0.997	0.989	0.983	0.977	0.971
Snap Bean	1.000	0.995	0.987	0.978	0.971	0.964

Producer Yearly Price

Products	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Tomato	0.987	0.974	0.963	0.952	0.941	0.931
Bell Pepper	0.991	0.985	0.981	0.979	0.981	0.987
Squash	0.987	0.975	0.965	0.955	0.946	0.939
Cucumber	0.985	0.974	0.962	0.951	0.941	0.932
Eggplant	0.992	0.986	0.980	0.974	0.968	0.962
Snap Bean	0.996	0.989	0.985	0.981	0.975	0.970

Producer Revenue

Products	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Tomato	0.987	0.972	0.958	0.945	0.932	0.919
Bell Pepper	0.991	0.985	0.979	0.976	0.977	0.983
Squash	0.987	0.975	0.962	0.950	0.940	0.931
Cucumber	0.985	0.963	0.938	0.916	0.896	0.877
Eggplant	0.992	0.983	0.969	0.957	0.945	0.934
Snap Bean	0.996	0.985	0.972	0.959	0.947	0.935

Note: Numbers are calculated as scenario result in year "t" divided by baseline result in year "t".

Aggregate winter vegetable producer revenue in Florida decreases by 6.3%, from $952.253 to $892.580 million. Individual producing sectors lose as follows: tomato, $34.652 million; cucumber, $12.012 million; bell pepper, $5.215 million; snap bean, $3.304 million; squash, $3.303 million; eggplant, $1.187 million. A ranking of the vulnerability of individual sectors can be measured by the percentage reductions in producers' revenues: cucumber, 12.3 percent; tomato, 8.1 percent; squash, 6.9 percent; eggplant, 6.6 percent; snap bean, 6.5 percent; and bell pepper, 1.7 percent.

Figure 3 shows a comparison of yearly producer revenue growth rates

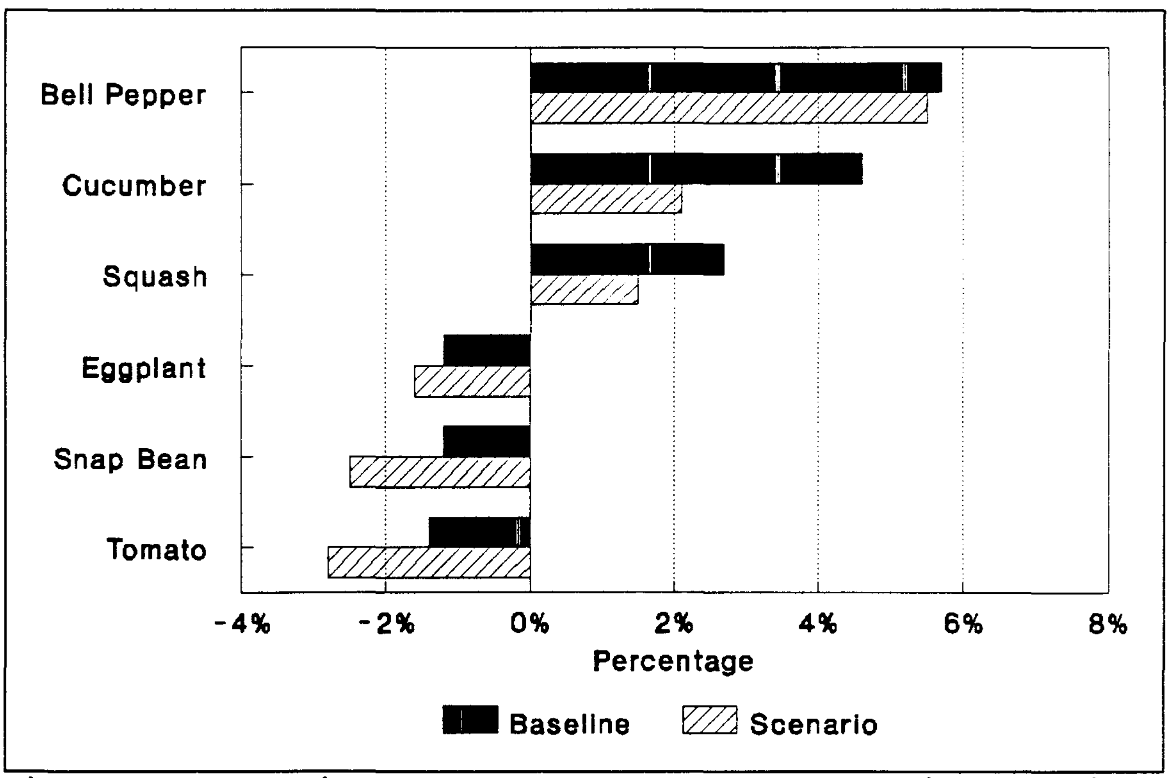

Figure 3 - Comparison of Producer Revenue Growth with Baseline

between the import scenario and the baseline. Differences appear wide for cucumbers, squash, snap beans, and tomatoes; and fairly close for bell peppers and eggplant. When the rates are tested for the null hypothesis that their differences are indistinguishable from zero, the hypothesis is rejected only for squash and tomatoes.

Supply Shocks and Import Response

The other way to examine the vulnerability of individual Florida vegetable sectors is to see how the availability of imports affects the sectors' ability to adjust to supply shocks. Most supply shocks are the result of freezing temperatures. Major freezes in 1985 and 1990 caused major production shortfalls for the entire vegetable sector. The market's remedy is for higher prices to compensate for lower shipment quantities. If demand is extremely elastic (because the product has ready substitutes) or if imports are readily available (supplies from Mexico or elsewhere), the market remedy will bring little compensation. Although the producer cannot commonly influence the demand for the product, political or legislative means may be available to curb the import threat.

Supply shocks tend to affect shipment levels over a two-month time frame. As might be expected, the months of January, February, and March are the most prone to major freezes. In 1985, the largest reductions occurred for squash and cucumbers during February and March than at any other time. For the two month period, squash shipments decreased 60 percent relative to normal levels, and cucumber shipments decreased 49 percent. In 1990, the largest reductions occurred for the other winter vegetables during January and February. For the period, shipments were much reduced below normal levels: tomatoes, 81 percent; bell peppers, 70 percent; eggplant, 74 percent; and snap beans, 90 percent. These supply shocks, measured as a proportion of average yearly shipments, have been the largest for snap beans (16.0 percent) and tomatoes (15.6 percent). Less affected have been eggplant (10.3 percent), squash (8.5 percent), bell pepper (8.4 percent), and cucumbers (4.9 percent).

Table 9 - Supply Shocks Used in Modeling Experiment

Product	January	February	March	Shock Size relative to Yearly Production
Tomato 1000 Cartons	6226	4294	-	15.6%
Bell Pepper 1000 Bushels	1068	1044	-	8.4%
Squash 1000 Bushels	-	276	103	8.5%
Cucumbers 1000 1 1/9 Bushels	-	89	226	4.9%
Eggplant 1000 Bushels	139	78	-	10.3%
Snap Beans 1000 Bushels	505	213	-	16.0%

Use of the framework for analysis consists in shocking shipments for the two-month period by the largest amounts observed during the 1985-94 period. These amounts are those referred to above and are summarized in Table 9. For each supply shock, three import responses are considered. In the first instance, there is no response. This case represents the best-case scenario for Florida producers. The second case specifies that 12.5 percent of the reduction amount is matched by an increase in imports. The third case specifies 25 percent in like manner.

Table 10 summarizes the results. The "no import response" case shows that there is market-generated compensation for the producer resulting from higher shipment prices. However, with the exception of tomatoes, it is not much. Although the tomato price increases by over 30 percent, the change for the other vegetables is decidedly less: bell peppers, 5.5 percent; snap beans, 4.3 percent; squash, 2.4 percent; cucumber, 1.5 percent; and eggplant, -0.5 percent.

Tomatoes clearly stand apart. With no increase in tomato imports, tomato producer revenue can actually increase rather than decrease. This increase is directly linked to the relatively inelastic demand elasticities corresponding to the hypothetical two-month freeze period. However, if imports increase by 25 percent of the supply shock quantity in the same period as the supply shock occurs, increased producer revenues disappear. In this circumstance, tomato growers are likely to be concerned with the supply-capabilities of

Table 10 - Price Effects of Supply Shocks and Import Responses

Product	Base	0%	12.5%	25%
Tomato (Dollar/carton)				
January	9.779	35.860	28.466	23.240
February	4.760	17.641	14.092	11.537
Year	6.856	9.015	8.489	8.075
Bell Pepper (Dollar/bushel)				
January	9.650	11.062	10.852	10.654
February	7.651	9.624	9.318	9.033
Year	9.131	9.630	9.565	9.503
Squash (Dollar/bushel)				
February	6.654	7.196	7.119	7.045
March	11.482	11.824	11.773	11.722
Year	9.428	9.650	9.638	9.626
Cucumber (Dollar/unit*)				
February	8.945	9.065	9.050	9.034
March	8.952	9.297	9.251	9.205
Year	11.573	11.758	11.751	11.744
Eggplant (Dollar/bushel)				
January	8.057	10.406	10.019	9.666
February	14.978	16.472	16.259	16.054
Year	8.723	8.676	8.650	8.626
Snap Bean (Dollar/bushel)				
January	12.011	15.094	14.391	13.845
February	12.085	14.726	14.005	13.434
Year	12.499	13.039	12.924	12.832

* = 1 1/9 bushel

competitors in terms of both volume and timing.

Other vegetable sectors are less affected by the presence of increased imports (figure 4). Bell peppers are affected by more than the others: revenue losses increase 35 percent when imports

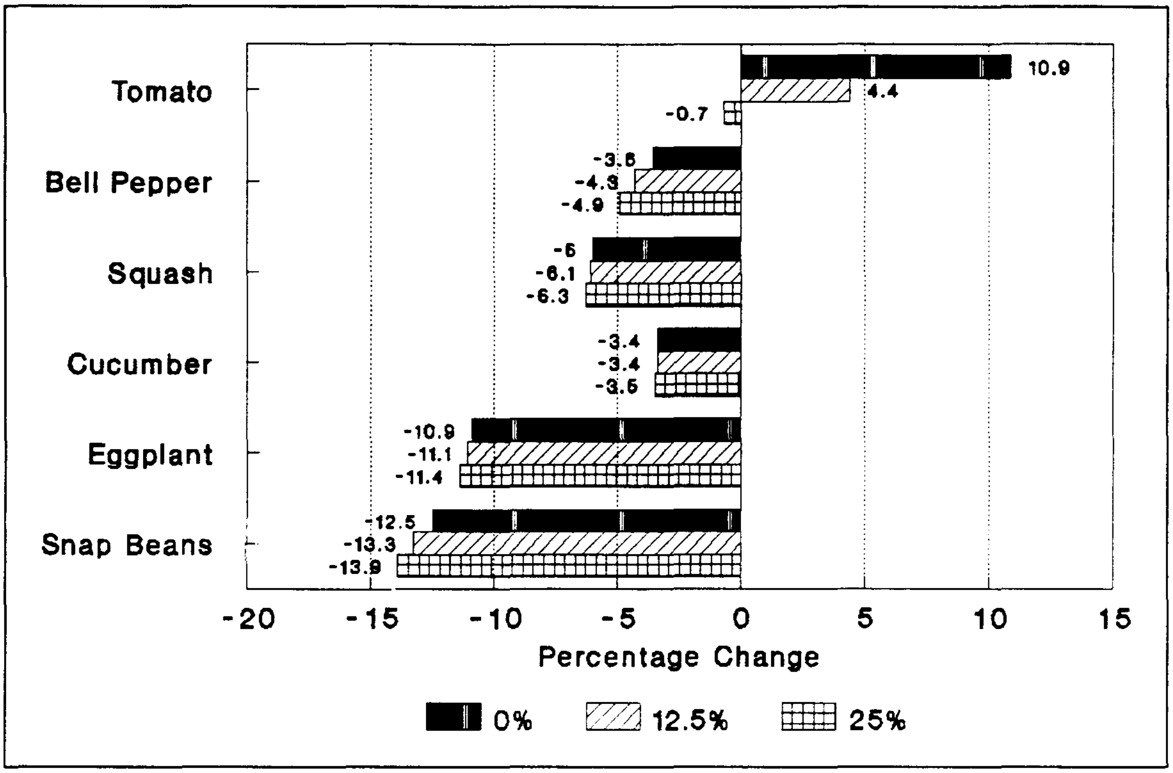

Figure 4 - Change in Yearly Producer Revenues

increase by 25 percent of supply shock effect. Snap bean revenue losses are 11 percent higher. Squash, cucumber, and eggplant revenue losses are not much affected: they increase by less than 5 percent.

Conclusions

Concern over the state of the Florida winter vegetable industry is longstanding and is not likely to dissipate. Individual producing sectors have long faced Mexican competition. With NAFTA a reality, investment flows into Mexico make increased winter vegetable production and increased exports to the United States more likely.

Florida producers, especially those producing tomatoes, have paid close attention to Mexican developments. They have not been hesitant about using political ends to achieve economic results when it has come to import competition.

Trends within individual vegetable sectors have not been uniform. Since 1985, bell peppers, squash, and cucumbers have experienced the most growth during the winter season. Tomatoes have achieved less but still positive growth, while eggplant and snap bean growth has been fairly flat. Demand growth, where it exists, has benefitted both Florida and Mexico. There are no significant statistical distinctions between the respective shipment growth rates.

The future will bring competitive challenges to the Florida industry. One of the many ways to analyze competitiveness issues is the projections modeling approach. The analytical system employed in this paper has incorporated several distinguishing characteristics of the industry, including seasonability, variability in monthly shipment levels, and the diversity of producing areas within Florida. Missing, however, has been the like treatment of the Mexican winter vegetable sector. Assumptions about imports are made to test hypotheses about the Florida industry. The reasonableness of the assumptions about Mexico will require subsequent independent analysis.

Baseline analysis suggests producer revenue growth for bell peppers, cucumbers, and squash. Cucumbers and squash are notable because they currently face the highest import competition exposure. Reductions in producer revenues are suggested for eggplant, snap beans, and tomatoes. Given weakness in demand growth for eggplant and snap beans, the predicted reductions are not surprising. Modest demand growth for tomatoes, it would seem, is increasingly being met by imported sources.

If Mexican imports increase significantly over the next few years, all Florida winter vegetable sectors will be affected. Compared to the favorable baseline results, cucumber and squash revenues would be much reduced. However, even if the imports grow by 25 percent of the 1993/94 levels, revenue growth should still be positive. Tomato, snap bean, and eggplant producers also face significant revenue losses. Unlike cucumbers and squash, the losses are coming on top of already predicted losses indicated in the baseline. With the large relative size of the tomato sector in particular, continued pressure in the political realm could be likely.

Every season, the Florida winter vegetable industry faces the possibility of major supply disruptions because of freezes or other weather-related events. Although the sectors are cushioned somewhat because growing and harvesting extends over several months, the sectors are reliant on some relief through upward price movements accompanying supply-shortfalls. The sector most affected in this regard is the tomato sector. Due to relatively inelastic demand during the period most prone to freezes, the market generates high prices when there are supply disruptions. This effect is very much muted for all the other winter vegetable sectors.

If shortfalls can be counteracted through increased imports, some of the relief is then absent. When Mexican tomato imports can be easily increased on short notice, the tomato price rise referred to above is much lessened. The effect on Florida tomato producers' revenue seems fairly strong even when only 25 percent of the shortfall is met by the equivalent volume rise in imports. This short-term effect on the Florida tomato industry again substantiates the concerns that its producers have about imports, as revealed in the longer-term analysis.

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Appendix

The purpose of this appendix is to review some of research literature concerning the Florida winter vegetable industry. The review is organized under topic areas: I - ERS monographs; II - cost of production comparisons between Florida and Mexico; III - changing comparative advantage and competitiveness; IV - productivity growth; V - market integration issues; and VI - modeling approaches.

I. ERS Monograph analyses of Florida-Mexico Winter Vegetable Competition are here listed:

VanSickle, John J., Emil Belibasis, Dan Cantiffe, Gary Thompson, Norm Oebker. (1994) Competition in the U.S. Winter Fresh Vegetable Industry. Econ. Res. Serv., U.S. Dept. Agr., AER No. 691.

Buckley, Katherine C., John J. VanSickle, Maury Bredahl, Emil Belibasis, Nicholas Gutierrez. (1986) Florida and Mexico Competition for the Winter Fresh Vegetable Market. Econ. Res. Serv., U.S. Dept. Agr., AER No. 556.

Zepp, G.A., R.L. Simmons. (1979) Producing Fresh Winter Vegetables in Florida and Mexico: Costs and Competition. Econ., Stat., and Coop. Serv., U.S. Dept. Agr., ESCS-72.

Simmons, R.L., James L. Pearson, and Earnest B. Smith. (1976) Mexican Competition for the U.S. Fresh Winter Vegetable Market. Econ. Res. Serv., U.S. Dept. Agr., AER No. 348.

Fliginger, C. John, Earle E. Gavett, Levi A. Powell, Sr., Robert P. Jenkins. (1969) Supplying U.S. Markets with Fresh Winter Produce: Capabilities of U.S. and Mexican Production Areas. Econ. Res. Serv., U.S. Dept. Agr., AER No. 154, also Supplement to Report, dated Sept. 1971.

Description: These reports contain descriptions of agro-economic conditions of major producing areas in Florida and Mexico, primarily Sinaloa. The reports describe policy effects, both specific to individual sectors (including U.S. import tariffs) and to the larger macro-economy. Shared analytical approaches emphasize comparisons of costs of production within the major producing areas, and comparisons of relative costs involved in marketing through the respective distribution channels. The reports reach conclusions regarding trends in competitiveness among the winter fresh vegetables.

II. Another study of Florida-Sinaloa tomato competition based on a comparison of costs of production is:

Taylor, Timothy G. (1992) "A Comparative Analysis of Costs for Fresh Market Tomatoes Produced in Florida and Sinaloa, Mexico," Food and Resource Economics Dept., Univ. of Florida, IW92-1.

III. An alternative method of analyzing changes in structural and technical underlying comparative production advantage is:

Tefertiller, Kenneth R., Ronald Ward. (1995) "Revealed Comparative Advantage: Implications for Competitiveness in Florida's Vegetable Industry," Agribusiness. Vol. 11(2). pp. 105-15.

Description: The authors find an alternative method for measuring changes in competitiveness for Florida's vegetable industry vis-a-vis suppliers from other regions. They reject the type of analysis which relies on a comparison of costs of production. The authors develop their own measure of changes in comparative production costs across regions. They base their index on a simple index of production response stripped of factors related to price changes. (Their index seems to measure shifts in a region's supply schedule for a particular product rather than movements within it.) They argue that their measure compares underlying trends in technical and structural factors between regions that may give a marginal cost advantage to one as opposed to the other.

IV. Two studies measuring and analyzing productivity growth for Florida winter vegetables are:

Taylor, Timothy G., Gary H. Wilkowske. (1984) "Productivity Growth in the Florida Fresh Winter Vegetable Industry," Southern Journal of Agricultural Economics. Vol., pp. 55-61.

Description: Using Tornqvist indices, the authors calculate measures of total factor productivity relative to a base period for several fresh vegetables produced in Florida. Based on their measures, the authors find support the contention that productivity growth has been important for keeping Florida producers competitive in winter vegetable markets.

Kalitzandonakes, Nicholas G., Timothy Taylor. (1990) "Competitive Pressure and Productivity Growth: The Case of the Florida Vegetable Industry," Southern Journal of Agricultural Economics. Vol., pp. 13-21.

Description: Using measures of total factor productivity, authors find evidence that there is a positive relationship between the level of competitive pressure and the rate of productivity growth for vegetables produced in Florida.

V. Two studies that consider market integration issues are:

Bredahl, Maury, Andrew Schmitz, Jimmye S. Hillman. (1987) "Rent Seeking in International Trade: The Great Tomato War," American Journal of Agricultural Economics. Vol. (1), pp. 1-10.

Description: The authors diagrammatically show the basis for rent seeking activity by domestic and foreign producers, either acting unilaterally or jointly. They present a history of tomato trade disputes with Mexico. They conclude that Florida and Mexican producers' efforts to act jointly through the formation of a coalition to increase joint economic returns are likely to fail. Free trade is likely to prevail over the longer term.

Jordan, Kenrick H., John J. VanSickle. (1995) " Integration and Behavior in the U.S. Winter Market for Fresh Tomatoes," Journal of Agricultural and Applied Economics. Vol. 1, pp. 127-37.

Description: The authors use causality tests to analyze market integration issues. They reject the hypothesis that the markets for Florida and Mexican tomatoes are segmented. Current prices in Florida and Mexico influence each other. However, there is a lack of symmetry in the price information flow. Mexican prices register more fully to contemporaneous changes in Florida prices than do Florida prices to Mexican prices. Lagged prices are important for explaining current prices in both cases. The authors conclude that short-run integration does not hold for Florida but cannot be rejected for Mexico. This conclusion is consistent with the notion that Florida acts as a price-leader. Also, the conclusion is not inconsistent with the assertion that Mexico follows a policy of export restraint: it utilizes its ability to modify exports to the U.S. market quickly by changing supplies in its own domestic market. Results also support the hypothesis that in the longer term, markets served by Florida and Mexico are integrated; that is, price changes in one area will eventually be reflected in the prices of the other area.

VI. One paper based on the use of a formal modeling system applied to vegetable trade between the United States and Mexico is:

Buxton, Boyd M., Donna Roberts. (1992) "Economic Implications of Alternative Free Trade Agreements for the U.S. Fresh Tomato and Tomato Paste Industries," Econ. Res. Serv., U.S. Dept. Agr., paper selected for presentation at AAEA Annual Meetings, Baltimore, Md.

Description: The authors use a trade model for analyzing the tariff reductions then being considered as part of a Free Trade Agreement with Mexico. The fresh tomato model includes the United States, Mexico, Canada, Israel, and a rest-of-world aggregate. The model reports annual results, uses a 1990 base, and accounts for production and consumption responses in a supply-demand framework that treats trade as a residual. Two of the 5 scenarios performed in the analysis deal exclusively with U.S. tariff reductions on

Mexican imports. Depending on the degree of supply-responsiveness to price changes, Mexican imports are predicted to rise 10 to 13 percent. U.S. fresh tomato production decreases, possibly by as much as 1.9 percent. U.S. producer revenue falls between 2.4 and 3.1 percent. U.S. consumers, unlike producers, benefit from expanded trade.